ARIZ 427
October 1, 1999
(13 Pages)

ASPHALT BINDER CONTENT OF ASPHALTIC CONCRETE MIXTURES BY THE IGNITION FURNACE METHOD

(An Arizona Method)

SCOPE

1. (a) This procedure describes a method for determining the percent asphalt binder content of asphaltic concrete mixtures, by ignition. The aggregate remaining can be used for sieve analysis as indicated in Section 6.

(b) This test method involves hazardous material, operations, and equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

(c) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

(d) Metric (SI) units and values are shown in this test method with English units and values following in parentheses. Values given for metric and English units may be numerically equivalent (soft converted) for the associated units, or they may be given as rounded or rationalized values (hard converted). Either the metric or English units along with their corresponding values shall be used in accordance with applicable specifications. See Appendix A2 of the Materials Testing Manual for additional information on the metric system.

APPARATUS

2. Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

(a) Forced air ignition furnace - capable of maintaining the temperature at 538 ± 5 °C (1000 ± 9 °F), with an internal weighing system thermally isolated from the furnace chamber and accurate to 0.1 gram. The balance shall be capable of

weighing a 3500 gram sample in addition to the sample baskets. A data collection system shall also be included so that the sample mass loss can be automatically determined to an accuracy of 0.1 gram and displayed during a test. The test is deemed complete when the measured mass loss does not exceed 0.01 percent of the sample mass for three consecutive one minute intervals. The furnace shall provide a printout that includes, as a minimum, the initial sample mass, sample mass loss, test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the sample mass loss does not exceed 0.01 percent of the total sample mass for three consecutive one minute intervals. A filter capable of reducing emissions to an acceptable level shall also be incorporated into the furnace. The furnace shall be vented into a hood or to the outside and be set up properly so that there are no noticeable odors escaping into the laboratory. The furnace will have a fan with the capability to pull air through the furnace to expedite the test and to reduce escape of smoke into the laboratory. The furnace shall be equipped so that the door cannot be opened until testing is complete.

(b) Stainless Steel Perforated Baskets - the baskets shall be an appropriate size that allow the samples to be a thickness which allows air to flow up through and around the sample particles. The sample shall be completely enclosed with screen mesh or perforated stainless steel plate or other suitable material. Screen mesh or other suitable material with openings of 2.36 mm (No. 8) has been found to perform well.

(c) Stainless Steel Catch Pan - of sufficient size to hold the sample baskets so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.

(d) Oven - capable of heating to 177 ± 3 °C (350 ± 5 °F).

(e) Scale(s) or balance(s) - capable of measuring the maximum mass to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

(f) Safety Equipment - safety glasses or face shield, high temperature gloves, and long sleeve jacket. Additionally, a heat resistant surface capable of withstanding 650 °C (1200 °F) and a protective cage capable of surrounding the sample baskets shall be provided.

(g) Miscellaneous Equipment - a pan larger than the sample basket(s) for transferring samples after ignition, spatulas, bowls, spoons, and wire brushes.

(h) Mixing apparatus - Mechanical mixing is recommended; 19 liter (20 quart) capacity mixer is required. (Hand mixing may be performed if desired.)

(i) Thermometer - temperature range 10 to 260 °C (50 to 500 °F).

(j) Hot plate - capable of maintaining at temperature of 149 ± 6 °C (300 ± 10 °F).

(k) For performing sieve analysis, apparatus as specified in Arizona Test Method 201.

SAMPLING

3. (a) For preparing calibration samples, obtain samples of aggregates in accordance with Arizona Test Method 105. Samples shall be adequately dried, if necessary, to a free-flowing condition in the portion passing the 4.75 mm (No. 4) sieve.

(b) For testing field samples of asphaltic concrete, obtain a sample of the freshly produced mix in accordance with Arizona Test Method 104. Obtain representative test samples for asphalt binder content and moisture content (if required) determination according to the appropriate sections of Arizona Test Method 416.

(c) The size of the asphalt binder content test sample shall conform to the mass requirement shown in the table below. When the mass of the test sample exceeds the capacity of the equipment used, the test sample may be divided in suitable increments, tested, and the results appropriately combined.

Size of Test Sample	
Nominal Maximum Aggregate Size	**Mass of Sample, grams**
37.5 mm (1-1/2 in.)	4000 - 4500
25.0 mm (1 in.)	3000 - 3500
19.0 mm (3/4 in.)	2000 - 2500
12.5 mm (1/2 in.)	1500 - 2000
9.5 mm (3/8 in.)	1200 - 1700
4.75 mm (No. 4)	1200 - 1700

CALIBRATION

4. This method may be effected by the type of aggregate in the mixture. A calibration factor must be established for each mix type. Certain aggregate types may result in an unusually high calibration factor and erroneous gradation results due to aggregate breakdown. Such mixes should be calibrated and tested at a lower temperature as described in paragraph 4(l).

(a) Weigh up four aggregate samples to the mix design gradation. These samples will be used for a gradation check, two calibration samples, and a butter mix. If mineral admixture is required by the mix design, the appropriate type and quantity shall be added to the aggregate and thoroughly blended. Each aggregate (and mineral admixture if required) sample shall be of an appropriate size so that, when the design asphalt binder content is added, it conforms to the requirements of Section 3(c). Aggregate used shall be sampled from material produced in the current construction season. Any method may be used to combine the aggregates as long as the resultant gradation is representative of the mix design.

(b) Dry the aggregate samples to constant mass at 143 ± 6 °C (290 ±10 °F).

(c) Using one of the prepared aggregate samples perform a gradation analysis according to Section 6 to determine the actual gradation. The gradation shall be representative of the mix design gradation. If the gradation is not representative of the mix design, four new aggregate samples shall be prepared.

(d) Using the remaining three aggregate samples prepare two calibration samples and a butter mix at the design asphalt binder content. The asphalt binder grade and type shall be the same as will be used in the asphalt concrete mixture to be tested. If during drying of aggregate, mass is lost, do not add make-up material, as this will change the gradation of the samples. The percent asphalt binder content is based on the mass of total mix. For each sample, the weight of asphalt binder to be used is determined by the following:

$$\left[\begin{array}{c}\text{Weight of}\\ \text{Asphalt}\\ \text{Binder}\end{array}\right] = \frac{\left[\begin{array}{c}\text{Weight of Aggregate}\\ \text{(and mineral admixture when used)}\end{array}\right]}{100 - \left[\begin{array}{c}\text{Percent of}\\ \text{Asphalt}\\ \text{Binder}\end{array}\right]} \times \left[\begin{array}{c}\text{Percent of}\\ \text{Asphalt}\\ \text{Binder}\end{array}\right]$$

(e) All bowls, sample pans, and mixing tools shall be preheated to the laboratory mixing temperature prescribed in the mix design. At the time mixing of the samples begins, the temperature of the asphalt binder and aggregate (and mineral admixture when used) shall be in accordance with the prescribed laboratory mixing temperature. All samples shall be mixed at the same mixing temperature ± 6 °C (10 °F).

(f) Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

(g) The freshly mixed samples may be placed directly in the sample basket assembly. If allowed to cool, the samples must be reheated in a 143 ± 6 °C (290 ± 10 °F) oven for 25 minutes. Do not preheat the sample baskets.

(h) Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or as modified in paragraph 4(l).

(i) Test samples in accordance with Section 5(e) through (m).

(j) If the difference between the measured asphalt binder content of the two samples exceeds 0.07, repeat the test using two additional samples, and from the four results discard the high and the low values.

(k) Subtract the actual asphalt binder content for each of the two samples from the measured asphalt binder content. The calibration factor is the average of the two resultant values expressed in percent by mass of the asphalt mixture.

(l) If the calibration factor exceeds 1.0 percent, lower the test temperature to 482 ± 5 °C (900 ± 9 °F) and repeat the test to determine a new calibration factor. If the calibration factor continues to exceed 1.0 percent, lower the test temperature to 427 ± 5 °C (800 ± 9 °F) and repeat the test to determine a new calibration factor. Use the calibration factor obtained at 427 ± 5 °C (800 ± 9 °F) even if it exceeds 1.0 percent.

(m) Perform a gradation analysis on the residual aggregate as indicated in Section 6. Subtract the actual percent passing the 75 µm (No. 200) sieve for each sample from the measured percent passing the 75 µm (No. 200) sieve [as determined in paragraph 4(c)]. Determine the average of the two values. If the resultant average value is greater than 0.50, a correction factor (equal to the resultant average value) for the passing 75 µm (No. 200) material may be applied to the production field sample test results.

PROCEDURE

5. (a) Preheat the ignition furnace to 538 ± 5 °C (1000 ± 9 °F), or to the alternate temperature determined during the calibration [Section 4(l)]. Record the furnace temperature set point prior to the initiation of the test.

(b) The moisture content shall be determined in accordance with Arizona Test Method 406. The moisture content sample shall be obtained at the same time and subjected to the same treatment prior to testing as the asphalt binder content test sample. As an alternate to performing the moisture determination, the test sample may be dried to a constant mass in an oven at 143 °C ± 6 °C (290 °F ± 10 °F).

(c) Enter the calibration factor for the specific mix to be tested as determined in Section 4(j) through (l).

(d) Weigh and record the mass of the basket assembly to the nearest 0.1 gram.

(e) Evenly distribute the asphalt binder content test sample over the entire area of the sample basket(s). Use a spatula or trowel to pull material approximately 25 mm (one inch) away from the outside edge of basket(s) and level the material.

(f) Weigh and record the mass of the sample and basket assembly to the nearest 0.1 gram.

(g) Calculate and record the initial mass of the sample to the nearest 0.1 gram.

(h) Set the ignition furnace controller print mode to give a printout of all test data. Input the initial mass of the sample into the ignition furnace controller. Verify that the correct mass has been entered.

(i) Open the furnace door and place the sample and basket assembly so that it is centered in the chamber. After assuring that the sample basket assembly is not in contact with any wall, close the door. Initiate the test by pressing the start button. This will lock the furnace door and start testing.

(j) Allow the test to continue until the stable light and audible stable indicator indicates the test is complete (the change in mass does not exceed 0.01 percent for three consecutive minutes). If required, press the stop button. This will unlock the furnace door and cause the printer to print out the test results.

(k) Open the furnace door, remove the sample and basket assembly. Allow the sample to cool 30 ± 5 minutes in the basket assembly. Weigh and record the mass of the sample and basket assembly after ignition to the nearest 0.1 gram.

(l) Calculate and record the mass of sample after ignition to the nearest 0.1 gram.

(m) Calculate and record the asphalt binder content of the sample, to the nearest 0.01%, as follows:

$$\%AC = \left[\frac{W_i - W_A}{W_i} \times 100 \right] - C_F - \%M$$

Where: %AC = measured (corrected) asphalt binder content in percent by mass of the sample
W_i = total mass of the sample prior to ignition
W_A = total mass of sample after ignition
C_F = calibration factor, percent by mass of sample
%M = percent moisture in sample

NOTE: During calibration, C_F and %M are zero.

(n) Attach the original printed ticket to the back of the card.

(o) Empty the contents of the baskets into a flat pan. Use a small wire sieve brush to ensure that any residual fines are removed from the baskets.

(p) If needed, perform a gradation analysis on the residual aggregate according to Section 6.

SIEVE ANALYSIS OF AGGREGATE

6. If required, the aggregate shall be subjected to sieve analysis as described below. The coarse sieving shall be performed in accordance with paragraph (a), and the fine sieving in accordance with paragraph (b). The quantity of material on a given sieve at the completion of sieving shall not exceed the amount shown in the table below.

Sieve Size		Maximum Mass Allowed		Maximum Mass Allowed (grams) 304.8 mm (12" Dia. Sieve)
		grams/cm^2	(grams/sq. in.)	
37.5 mm	1-1/2"	3.88	25	2829
25.0 mm	1"	2.79	18	2036
19.0 mm	3/4"	2.17	14	1583
12.5 mm	1/2"	1.55	10	1131
9.5 mm	3/8"	1.24	8	905
6.3 mm	1/4"	0.93	6	679
4.75 mm	No. 4	0.78	5	567
2.36 mm	No. 8	0.62	4	452
2.00 mm and smaller	No. 10 and smaller	0.62	4	---

(a) The coarse sieving of the aggregate shall be performed as follows:

(1) Weigh and record the mass of the sample to be sieved to the nearest gram. Place sample on the top sieve of a nest of 304.8 mm (12 inch) sieves. The nest of sieves shall consist of sieves starting with the smallest size sieve that 100% of the material will pass, down to and including the 2.36 mm (No. 8) sieve and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

(2) Weigh and record separately, to the nearest gram, the mass of the material retained on the individual sieves and in the pan. The material retained in the pan is recorded as the minus 2.36 mm (No. 8) material.

(3) Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus 2.36 mm (No. 8) material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

(4) Determine the coarse sieve factor by dividing 100 by the total mass sieved. Record the factor to at least six decimal places.

(5) The percent passing for each sieve in the coarse sieve analysis is determined by multiplying the mass retained on that sieve times the coarse sieve factor, and subtracting the result from the unrounded % passing for the next larger sieve. Values for "mass retained times the coarse sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to at least six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent.

(6) As a check on the coarse sieve analysis, multiply the mass of minus 2.36 mm (No. 8) material times the coarse sieve factor. The result of this calculation, rounded to the nearest percent, should be the same as the value for percent passing the 2.36 mm (No. 8) sieve determined in the paragraph above.

(7) The material passing the 2.36 mm (No. 8) sieve is split, if necessary, to obtain an approximate 500 gram sample for fine sieving. If less than 800 grams passes the 2.36 mm (No. 8) sieve, the entire amount may be subjected to fine sieving. The mass of the sample for fine sieving is recorded to the nearest gram as mass of pass 2.36 mm (No. 8) split.

(b) The elutriation and fine sieving of the pass 2.36 mm (No. 8) material shall be performed as follows:

(1) Subject sample to elutriation through a 75 µm (No. 200) screen either by hand or mechanical washing.

(2) Dry sample to constant mass, allow to cool, then weigh and record the dry mass to the nearest gram.

(3) Place sample on the top sieve of a nest of fine sieves. The nest of sieves shall consist of sieves starting with the 2.00 mm (No. 10) down through and including the 75 µm (No. 200) and pan. Place lid on nested sieves and screen the material by either mechanical or hand shaking, until not more than 0.5 percent by mass of sample passes any sieve during one minute.

(4) Weigh and record separately, to the nearest gram, the mass of material retained on the individual sieves and in the pan.

(5) Do not discard any of the sieved material until the sum of the individual masses is compared to the mass of the sample prior to sieving. If the difference between the two masses is less than or equal to 1.0% of the mass of the

sample prior to sieving, an adjustment in mass shall be made on the sieve which has the largest mass retained, except no adjustment shall be made on the minus 75 µm (No. 200) material. If the difference is greater than 1.0%, the sample shall be recombined, resieved, and carefully reweighed.

(6) Determine and record elutriation to nearest gram by determining the difference between the dry mass and the mass of the pass 2.36 mm (No. 8) split.

(7) Determine a factor for calculating the fine sieve analysis by dividing the percent passing the 2.36 mm (No. 8) sieve (recorded to the nearest percent) by the mass of pass 2.36 mm (No. 8) split. Record the factor to at least six decimal places. If all the pass 2.36 mm (No. 8) material from coarse sieving was subjected to elutriation and fine sieving, a fine sieve factor is not determined. Rather, the coarse sieve factor is utilized and the calculation of the percent passing each sieve is continuous through the entire sieve analysis.

(8) The percent passing for each sieve in the fine sieve analysis is determined by multiplying the mass retained on that sieve times the fine sieve factor, and subtracting the result from the unrounded % passing the next larger sieve, with the exception of the percent passing the 2.36 mm (No. 8) which has previously been recorded to the nearest percent. Values for "mass retained times the fine sieve factor" and "percent passing each sieve" shall be determined and used in the calculations to at least six decimal places. The percent passing value for each sieve is recorded in the sieve analysis to the nearest percent, except the percent passing the 75 µm (No. 200) sieve is recorded to the nearest 0.1 percent.

(9) As a check on the fine sieve analysis, the mass of material passing the 75 µm (No. 200) sieve is added to the elutriation mass, and this total is multiplied times the fine sieve factor. The result of this calculation, rounded to the nearest 0.1 percent, should be the same as the value for the percent passing the 75 µm (No. 200) sieve determined in the paragraph above.

(10) If a correction factor is utilized, the percent passing the 75 µm (No. 200) sieve shall be adjusted by subtracting the correction factor determined in paragraph 4(m).

(c) Other methods may be used that differ from that specified in paragraphs (a) and (b) above to determine % passing each sieve, so long as the method utilized has been proven to give equivalent results. However, any procedure which includes recording percent retained values prior to completing the calculation of all percent passing values is not allowed.

REPORT AND EXAMPLE

7. Report all information on the Asphaltic Concrete Tabulation Laboratory Card. An example of a completed card is shown in Figure 1. A blank card is provided in Figure 2.

(a) Mass of basket assembly.

(b) Mass of sample and basket assembly.

(c) Calculated initial mass of the sample.

(d) Mass of sample and basket assembly after ignition.

(e) Calculated mass of sample after ignition.

(f) Calibration factor.

(g) Percent moisture from moisture test, if one was performed.

(h) Corrected percent asphalt binder content.

(i) Elapsed time of test.

(j) Name of the operator.

(k) Sample test date.

(l) Design percent asphalt binder content.

(m) Ignition furnace set temperature.

(n) If determined, the sieve analysis of the residual aggregate [corrected for passing the 75 µm (No. 200) sieve if applicable].

ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION - IGNITION FURNACE (ENGLISH)

USE CAPITAL LETTERS

LAB NUMBER	ORG NUMBER	MATL	TYPE	PUR-POSE	TEST LAB	SIZE	SIZE %
99-7777	8888	AC	34	A	P		

TEST NO.	LOT OR SUFFIX	SAMPLED BY	MO	DAY	YEAR	TIME
4	3	A. JONES	12	21	99	3:25 ☐ AM ☒ PM

SAMPLED FROM	LIFT NO.	RDWY	STATION
ROADWAY - 10' RT. OF ℄	1	NB	99+50 (IF MILEPOST, INPUT DECIMAL)

ORIGINAL SOURCE	PROJECT ENGINEER / SUPERVISOR	PROJECT NUMBER	TRACS NUMBER
PETRIFIED FOREST PIT #2	B. SMITH	F-099-9(99)	H999901C

REMARKS: SHRP

EXAMPLE

COARSE FACTOR: .045455 FINE FACTOR: .088409

	WEIGHTS RETAINED	% RET	% PASS	SPECS
3" ☐				
2 1/2"				
2"				
1 1/2"				
1"			100	
3/4"	96	4	96	
1/2"	439	20	76	
3/8"	132	6	70	
1/4"	172	8	62	
#4	160	7	55	
#8	207	10		
-#8	994	✓	45	
Total	2200	= i (Rounded)		

Weight of Pass #8 Split: 509 = o

	WEIGHTS RETAINED	% RET	% PASS	SPECS
#10	56	5	40	
#16	34	3	37	
#30	101	9	28	
#40	78	7	21	
#50	23	2	19	
#100	113	10	9	
#200	44	4		
-#200	2	✓ q	5.3	
Total	451	p = Dry Weight		
Elutriation	58	= o - p		

% Pass No. 200 Correction Factor: 0.6 r

q - r = 4.7 Corrected % Pass No. 200

ARIZ. 427 (Ignition Furnace Test)

a.	Wet Mass of Moisture Sample	1026.2 g
b.	Dry Mass of Moisture Sample	1024.0 g
c.	Moisture Content (ARIZ 406) [(a - b) / a] x 100	0.21 %
d.	Mass of Basket Assembly	447.36 g
e.	Mass of Sample and Basket Assembly	6790.3 g
f.	Initial Mass of Sample (e - d)	2316.7 g
g.	Ignition Furnace Set Temperature	538 °C
h.	Mass of Sample and Basket Assembly After Ignition	6674.0 g
i.	Mass of Sample After Ignition (h - d)	2200.4 g
j.	Uncorrected Asphalt Binder Content [(f - i) / f] x 100	5.02 %
k.	Calibration Factor	0.28 %
l.	Corrected Asphalt Binder Content (j - k - c)	4.53 %
m.	Design Asphalt Binder Content	4.70 %
n.	Elapsed Time of Test	79 Minutes

WHITE ☐
YELLOW ☐
BLUE ☐

RECEIVED DATE	TEST OPERATOR AND DATE	SUPERVISOR AND DATE
12-21-99	Joe Tester 12-22-99	Ted Headman 12-22-99

†● 44-9372 R7/99

FIGURE 1

ARIZONA DEPARTMENT OF TRANSPORTATION

ASPHALTIC CONCRETE TABULATION - IGNITION FURNACE (ENGLISH)

USE CAPITAL LETTERS

LAB NUMBER | ORG NUMBER | MATL | TYPE | PUR-POSE | TEST LAB | SIZE | SIZE %

TEST NO. | LOT OR SUFFIX | SAMPLED BY | MO DAY YEAR | TIME ☐ AM ☐ PM

SAMPLED FROM | LIFT NO. | RDWY | STATION (IF MILEPOST, INPUT DECIMAL)

ORIGINAL SOURCE | PROJECT ENGINEER / SUPERVISOR | PROJECT NUMBER | TRACS NUMBER

REMARKS

COARSE FACTOR | FINE FACTOR

WEIGHTS RETAINED		% RET	% PASS	SPECS
3" ☐				
2 1/2"				
2"				
1 1/2"				
1"				
3/4"				
1/2"				
3/8"				
1/4"				
#4				
#8				
- #8				
Total	= i (Rounded)			

Weight of Pass #8 Split = o

WEIGHTS RETAINED		% RET	% PASS	SPECS
#10				
#16				
#30				
#40				
#50				
#100				
#200				
-#200			q	
Total	p = Dry Weight			
Elutri-ation	= o - p		q - r	Corrected % Pass No. 200

% Pass No. 200 Correction Factor = r

ARIZ. 427 (Ignition Furnace Test)

a. Wet Mass of Moisture Sample — g
b. Dry Mass of Moisture Sample — g
c. Moisture Content (ARIZ 406) [(a - b) / a] x 100 — %

d. Mass of Basket Assembly — g
e. Mass of Sample and Basket Assembly — g
f. Initial Mass of Sample (e - d) — g
g. Ignition Furnace Set Temperature — °C
h. Mass of Sample and Basket Assembly After Ignition — g
i. Mass of Sample After Ignition (h - d) — g
j. Uncorrected Asphalt Binder Content [(f - i) / f] x 100 — %
k. Calibration Factor — %
l. Corrected Asphalt Binder Content (j - k - c) — %
m. Design Asphalt Binder Content — %
n. Elapsed Time of Test — Minutes

WHITE ☐
YELLOW ☐
BLUE ☐

RECEIVED DATE | TEST OPERATOR AND DATE | SUPERVISOR AND DATE

†● 44-9372 R7/99

FIGURE 2